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Correlation Between Magnetic, Magnetoelastic and Magnetotransport Properties of $Eu_{0.55}Sr_{0.45}MnO_3$ Manganite due to Phase Separation

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We have found the close relation between magnetic, magnetoelastic and magnetotransport properties for $Eu_{0.55}Sr_{0.45}MnO_3$ ceramics. The resistivity ρ shows an insulating behaviour even at low temperatures ($\rho_{T=4.2\ K}$ = 10^6 Ω·cm). Near Neel temperature T_N we have observed a break on the $\rho(T)$ dependence and a small bump on temperature dependence of the thermal expansion. Under magnetic field B = 4.5 T ρ decreases in 10^3 times. Volume magnetostriction (ω) is negative in the 4.2 – 120 K interval and achieves giant value $\omega \sim 10^{-3}$ in the same B. The sharp jump on ω, ρ and magnetization (σ) isotherms at critical magnetic field B_C is observed. The value of B_C decreases with increasing T within 4.2 – 40 K interval and vice versa increases within 40 – 120 K one. All isotherms show a large hysteresis at increase and decrease of B. Besides unstability of σ, ρ and ω is observed at $B > B_C$. The maximal value of σ is less than one corresponding ferromagnetic (F) ordering of Mn ions, namely 70% from latter at 4.5 T. $Eu_{0.55}Sr_{0.45}MnO_3$ is a doped antiferromagnetic (AF) semiconductor $EuMnO_3$ in which, as we propose, at low temperatures insulating magnetic two-phase state (MTPS) is realized. In such type of MTPS the charge carriers are concentrated into separated F droplets, because of the gain in the $s - d$ exchange energy and these droplets are located into insulating AF host. Observed properties are explained by evolution of MTPS at change of magnetic field and temperature.